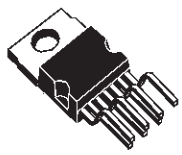
VND05B
VND05B (011Y) / VND05B (012Y)

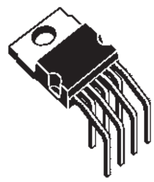
DOUBLE CHANNEL HIGH SIDE SMART POWER SOLID STATE RELAY

TYPE	V_{DSS}	$R_{DS(on)}$	I_n (*)	V_{CC}
VND05B VND05B (011Y) VND05B (012Y)	40V	200mΩ	1.6A	26 V

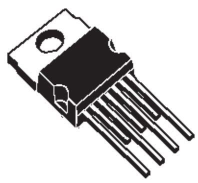
- OUTPUT CURRENT (CONTINUOUS): 9A AT T_c=85°C PER CHANNEL
- 5V LOGIC LEVEL COMPATIBLE INPUT
- THERMAL SHUT-DOWN
- UNDERVOLTAGE PROTECTION
- OPEN DRAIN DIAGNOSTIC OUTPUT
- INDUCTIVE LOAD FAST DEMAGNETIZATION
- VERY LOW STAND-BY POWER DISSIPATION



HEPTAWATT (vertical)



HEPTAWATT (horizontal)



HEPTAWATT (in-line)

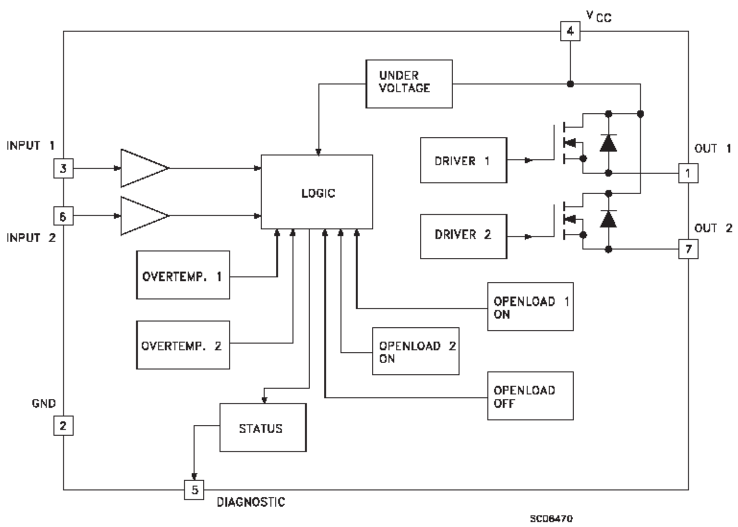
ORDER CODES

HEPTAWATT vertical	VND05B
HEPTAWATT horizontal	VND05B (011Y)
HEPTAWATT in-line	VND05B (012Y)

DESCRIPTION

The VND05B, VND05B (011Y), VND05B (012Y) is a monolithic device designed in STMicroelectronics VIPower technology, intended for driving resistive or inductive loads with one side connected to ground. This device has two channels, and a common diagnostic. Built-in thermal shutdown protects the chip from overtemperature and short circuit. The status output provides an indication of open load in on state, open load in off state, overtemperature conditions and stuck-on to V_{CC}.

BLOCK DIAGRAM

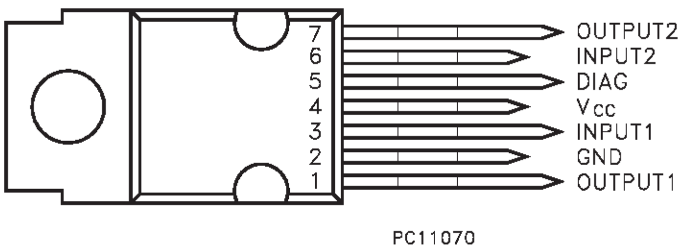


(*) I_n= Nominal current according to ISO definition for high side automotive switch (see note 1)

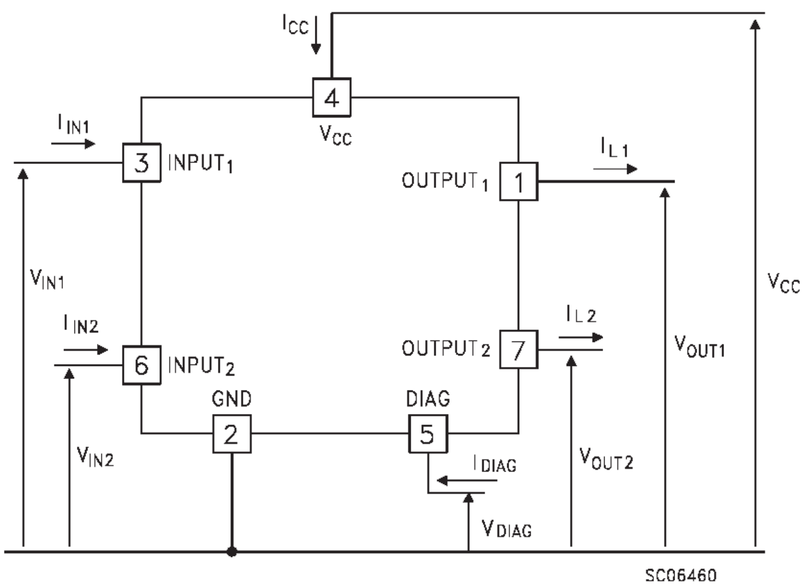
ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Value	Unit
$V_{(BR)DSS}$	Drain-Source breakdown voltage	40	V
I_{OUT}	Output current (continuous) at T_c=85°C	9	A
I_{OUT}(RMS)	RMS Output current at T_c=85°C and f > 1Hz	9	A
I_R	Reverse output current at T_c=85°C	-9	A
I_{IN}	Input current	+/- 10	mA
$-V_{CC}$	Reverse supply voltage	-4	V
I_{STAT}	Status current	+/- 10	mA
V_{ESD}	Electrostatic discharge (R=1.5kΩ, C=100pF)	2000	V
P_{TOT}	Power dissipation at T_c=25°C	59	W
T_j	Junction operating temperature	-40 to 150	°C
T_{STG}	Storage temperature	-55 to 150	°C

CONNECTION DIAGRAM TOP VIEW



CURRENT AND VOLTAGE CONVENTIONS



THERMAL DATA

Symbol	Parameter		Value	Unit
$R_{thj\text{-}case}$	Thermal resistance junction-case	(MAX)	2.1	°C/W
$R_{thj\text{-}amb}$	Thermal resistance junction-ambient	(MAX)	60	°C/W

ELECTRICAL CHARACTERISTICS (8V<V_{CC}<16V; -40°C≤T_j≤125°C; unless otherwise specified)

POWER

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CC}	Supply voltage		6	13	26	V
I_n (*)	Nominal current	T_c=85°C; $V_{DS(on)}$≤0.5V; V_{CC}=13V	1.6		2.6	A
R_{ON}	On state resistance	I_{OUT}=I_n; V_{CC}=13V; T_j=25°C	0.13		0.2	Ω
I_S	Supply current	Off state; T_j=25°C; V_{CC}=13V		35	100	µA
$V_{DS(MAX)}$	Maximum voltage Drop	I_{OUT}=7.5A; T_j=85°C; V_{CC}=13V	1.44		2.3	V
R_i	Output to GND internal impedance	T_j=25°C	5	10	20	KΩ

SWITCHING

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{d(on)}$ (^)	Turn-on delay time of output current	R_{OUT}=5.4Ω	5	25	200	µs
t_r (^)	Rise time of output current	R_{OUT}=5.4Ω	10	50	180	µs
$t_{d(off)}$ (^)	Turn-off delay time of output current	R_{OUT}=5.4Ω	10	75	250	µs
t_f (^)	Fall time of output current	R_{OUT}=5.4Ω	10	35	180	µs
$(di/dt)_{on}$	Turn-on current slope	R_{OUT}=5.4Ω	0.003		0.1	A/µs
$(di/dt)_{off}$	Turn-off current slope	R_{OUT}=5.4Ω	0.005		0.1	A/µs

LOGIC INPUT

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IL}	Input low level voltage				1.5	V
V_{IH}	Input high level voltage		3.5		(•)	V
$V_{I(hyst)}$	Input hysteresis voltage		0.2	0.9	1.5	V
I_{IN}	Input current	V_{IN}=5V; T_j=25°C		30	100	µA
V_{ICL}	Input clamp voltage	I_{IN}=10mA I_{IN}=-10mA	5	6 -0.7	7	V V

ELECTRICAL CHARACTERISTICS (continued)

PROTECTIONS AND DIAGNOSTICS

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{STAT}	Low output voltage status	I_{STAT}=1.6mA			0.4	V
V_{USD}	Undervoltage shut-down		3.5	4.5	6	V
V_{SCL}	Status clamp voltage	I_{STAT}= 10mA I_{STAT}= -10mA	5	6 -0.7	7	V V
T_{TSD}	Thermal shut-down temperature		140	160	180	°C
$T_{TSD(hyst)}$	Thermal shutdown hysteresis temperature				50	°C
T_R	Reset temperature		125			°C
V_{OL}	Open voltage level	Off state (note 2)	2.5	4	5	V
I_{OL}	Open load current level	On state	5		180	mA
t_{povl}	Overtemperature Status delay	(note 3)		5	10	µs
t_{pol}	Open Load Status delay	(note 3)	50	500	2500	µs

(*) I_n=Nominal current according to ISO definition for high side automotive switch (see note 1)

(^) See switching time waveform

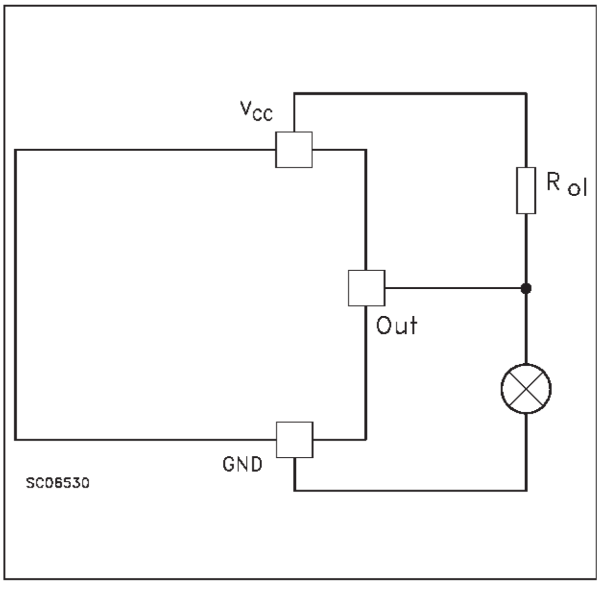
(•) The V_{IH} is internally clamped at 6V about. It is possible to connect this pin to an higher voltage via an external resistor calculated to not exceed 10 mA at the input pin.

Note 1: The Nominal Current is the current at T_c=85°C for battery voltage of 13V which produces a voltage drop of 0.5V

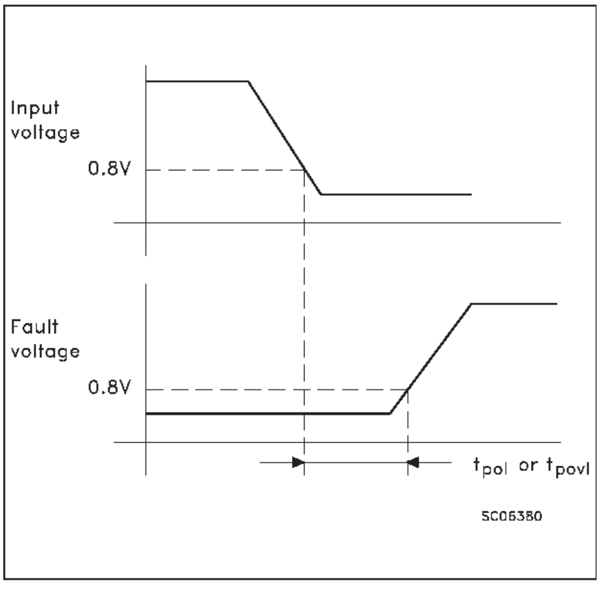
Note 2: $I_{OL(off)} = (V_{CC}-V_{OL})/R_{OL}$

Note 3: t_{povl} t_{pol}: ISO definition

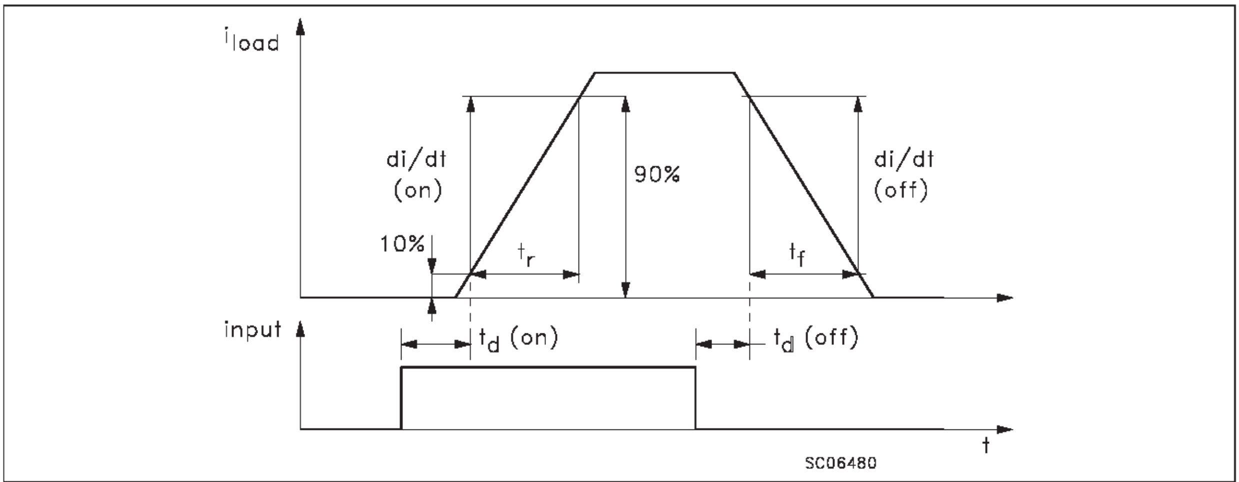
Note 2 Relevant Figure



Note 3 Relevant Figure



Switching Time Waveforms



FUNCTIONAL DESCRIPTION

The device has a common diagnostic output for both channels which indicates open load in on-state, open load in off-state, overtemperature conditions and stuck-on to V_{CC}.

From the falling edge of the input signal, the status output, initially low to signal a fault condition (overtemperature or open load on-state), will go back to a high state with a different delay in case of overtemperature (t_{povl}) and in case of open load (t_{pol}) respectively. This feature allows to discriminate the nature of the detected fault. To protect the device against short-circuit and overcurrent condition, the thermal protection turns the integrated PowerMOS off at a minimum junction temperature of 140°C. When this temperature returns to 125°C the switch is automatically turned in again. In short-circuit the protection reacts with virtually no delay, the sensor (one for each channel) being located inside each of the two PowerMOS areas. This positioning allows the device to operate with one channel in automatic thermal cycling and the other one on a normal load. An internal function of the devices ensures the fast demagnetization of inductive loads with a typical voltage (V_{demag}) of -18V. This function allows to greatly reduce the power dissipation according to the formula:

$$P_{dem} = 0.5 \bullet L_{load} \bullet (I_{load})^2 \bullet [(V_{CC}+V_{demag})/V_{demag}] \bullet f$$

where f= switching frequency and

V_{demag} = demagnetization voltage.

The maximum inductance which causes the chip temperature to reach the shutdown temperature in a specified thermal environment is a function of the load current for a fixed V_{CC}, V_{demag} and f according to the above formula. In this device if the GND pin is disconnected, with V_{CC} not exceeding 16V, both channels will switch off.

PROTECTING THE DEVICE AGAINST REVERSE BATTERY

The simplest way to protect the device against a continuous reverse battery voltage (-26V) is to insert a Schottky diode between pin 2 (GND) and ground, as shown in the typical application circuit (fig. 2).

The consequences of the voltage drop across this diode are as follows:

- If the input is pulled to power GND, a negative voltage of $-V_f$ is seen by the device. (V_{il}, V_{ih} thresholds and V_{STAT} are increased by V_f with respect to power GND).
- The undervoltage shutdown level is increased by V_f.

If there is no need for the control unit to handle external analog signals referred to the power GND, the best approach is to connect the reference potential of the control unit to the device ground (see application circuit in fig. 3), which becomes the common signal GND for the whole control board avoiding shift on V_{il}, V_{ih} and V_{STAT}. This solution allows the use of a standard diode.

THRUTH TABLE

		INPUT 1	INPUT 2	OUTPUT 1	OUTPUT 2	DIAGNOSTIC
Normal operation		L H L H	L H H L	L H L H	L H H L	H H H H
Undervoltage		X	X	L	L	H
Thermal shutdown	Channel 1	H	X	L	X	L
	Channel 2	X	H	X	L	L
Openload	Channel 1	H L	X L	H L	X L	L L
	Channel 2	X L	H L	X L	H L	L L
Output shorted to V_{CC}	Channel 1	H L	X L	H H	X L	L L
	Channel 2	X L	H L	X L	H H	L L

Figure: 1: Waveforms

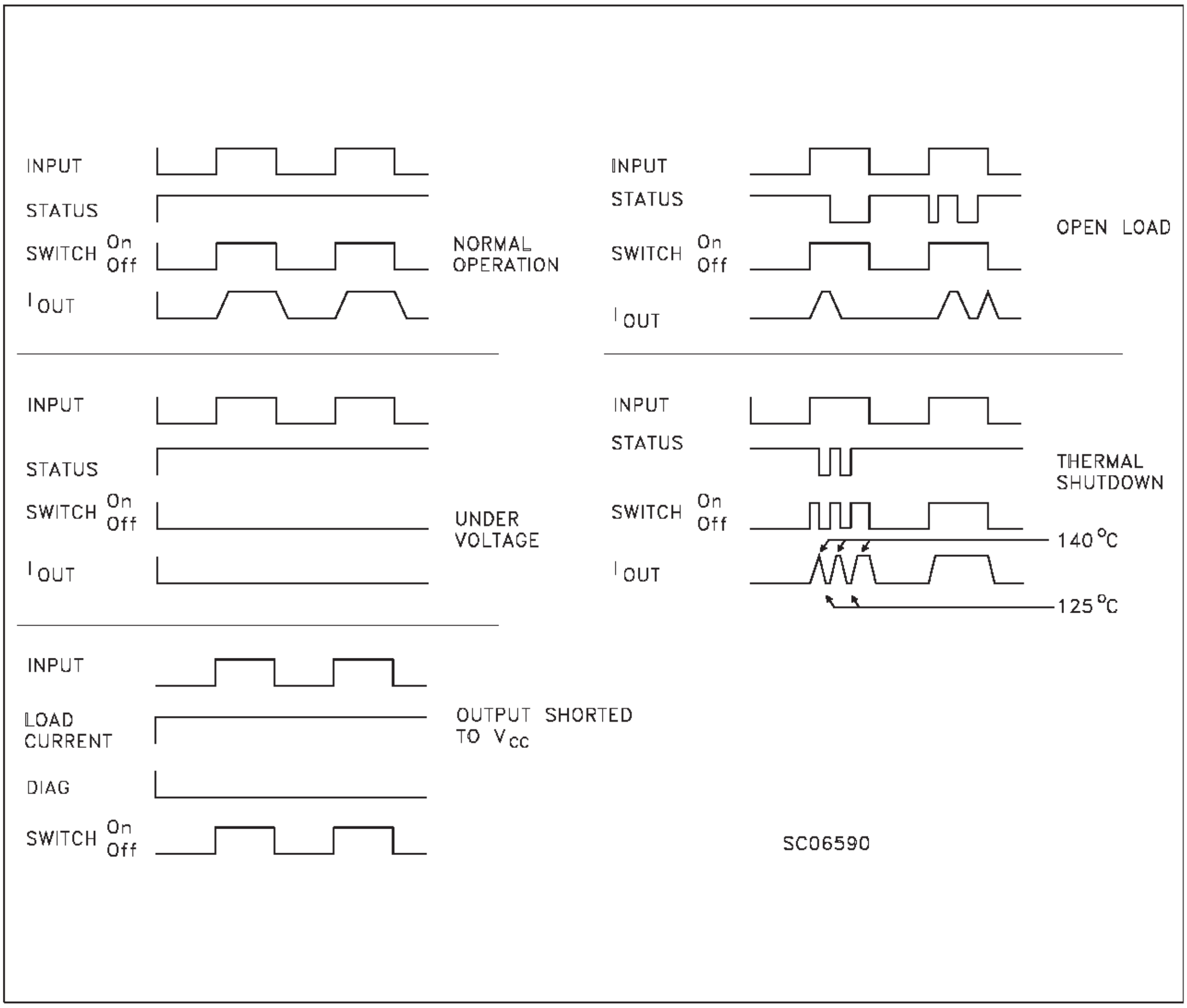


Figure 2: Typical application circuit with a Schottky diode for reverse supply protection

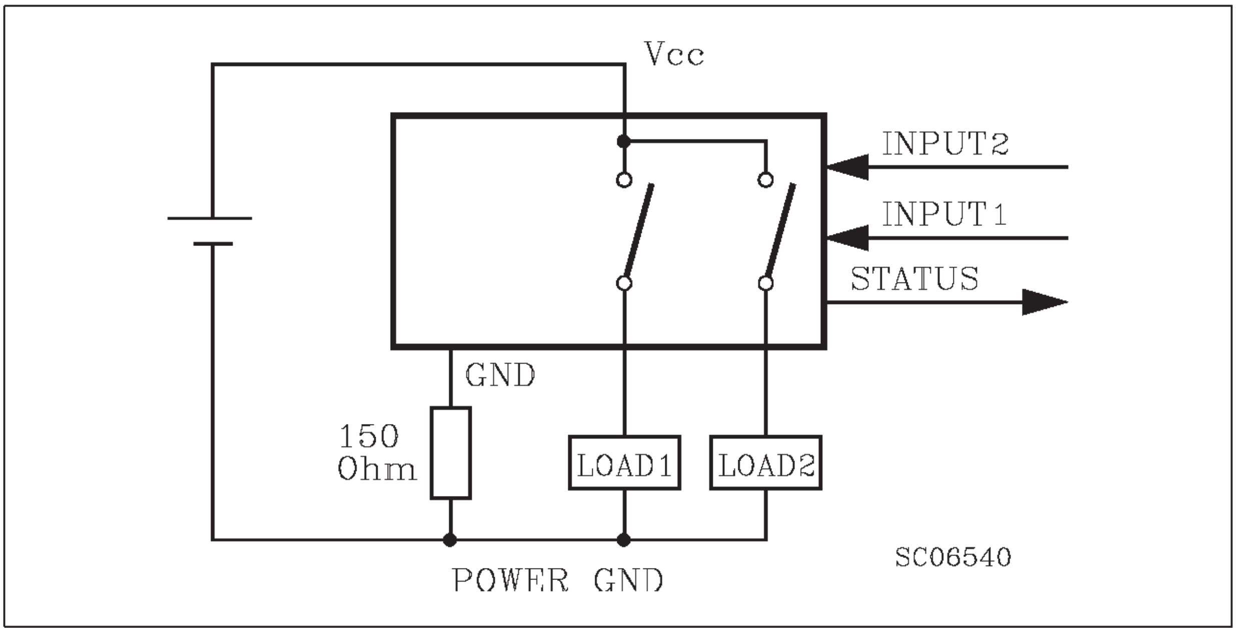
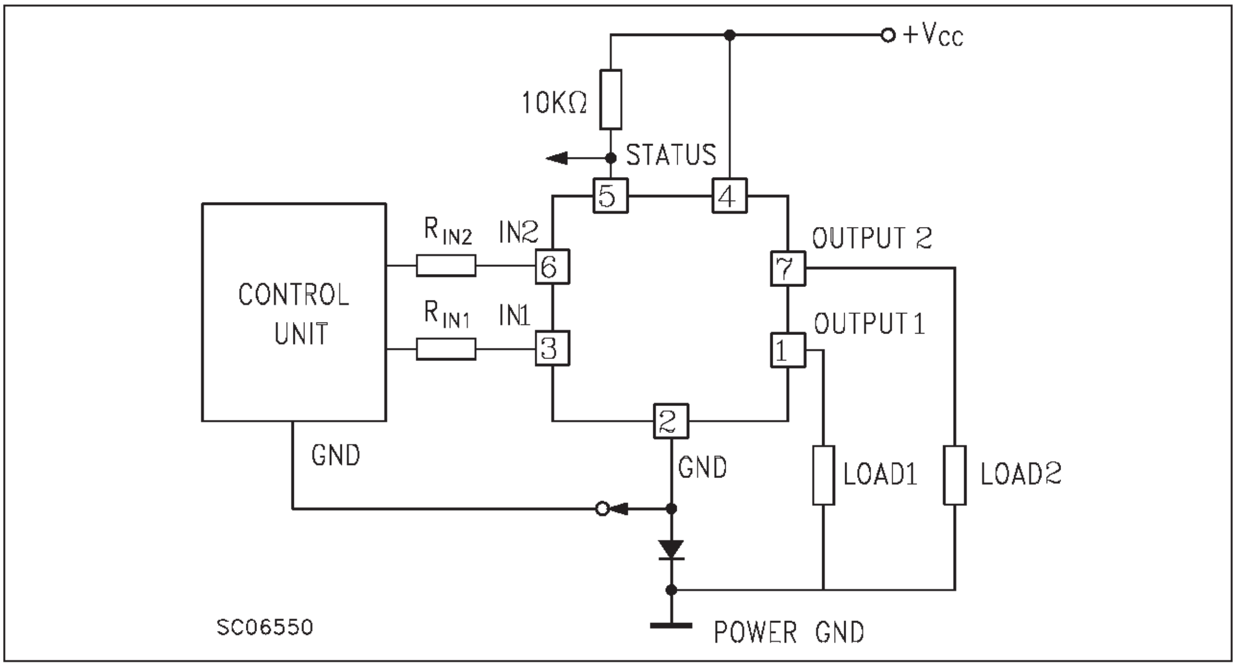
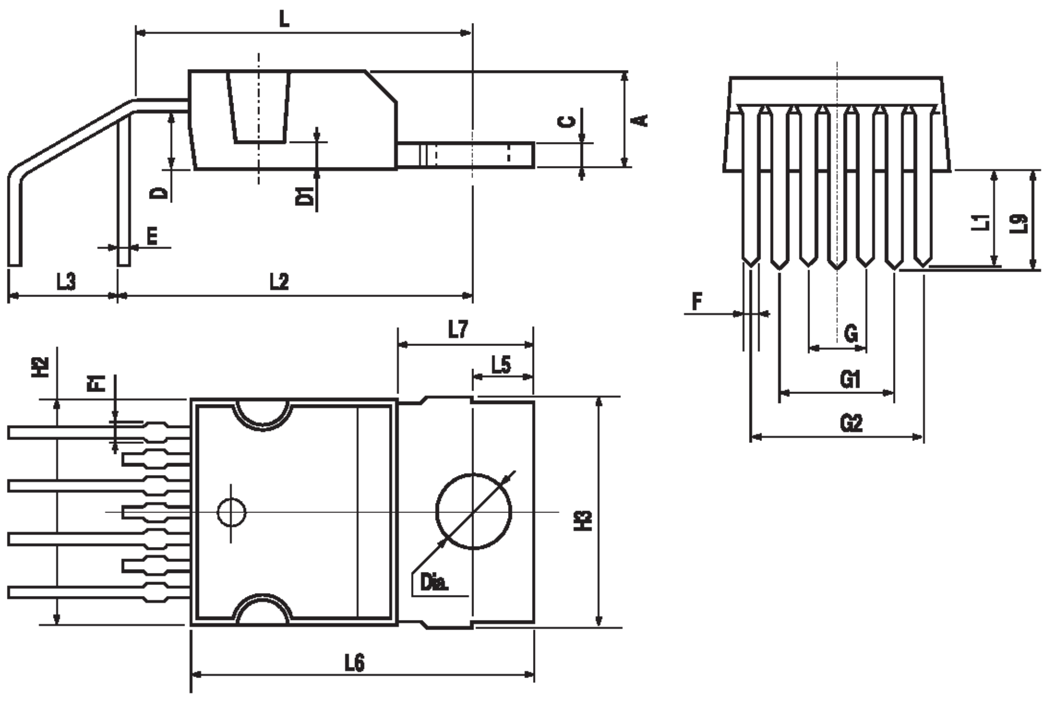


Figure 3: Typical application circuit with separate signal ground



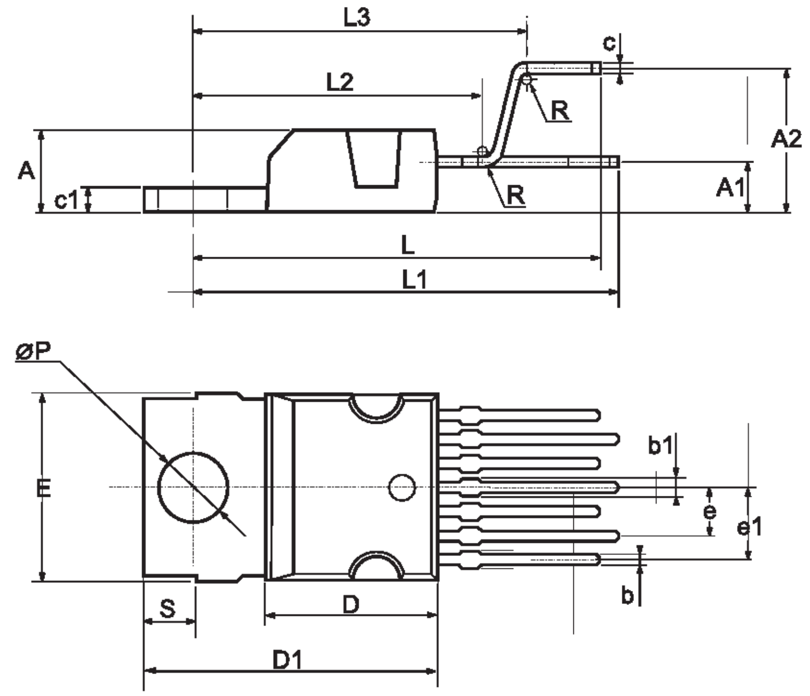
HEPTAWATT (horizontal) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		14.2			0.559	
L1		4.4			0.173	
L2		15.8			0.622	
L3		5.1			0.201	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
L9		4.44			0.175	
Dia	3.65		3.85	0.144		0.152



HEPTAWATT (vertical) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L		16.97			0.668	
L1		14.92			0.587	
L2		21.54			0.848	
L3		22.62			0.891	
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
M		2.8			0.110	
M1		5.08			0.200	



HEPTAWATT (in-line) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			4.8			0.189
C			1.37			0.054
D	2.4		2.8	0.094		0.110
D1	1.2		1.35	0.047		0.053
E	0.35		0.55	0.014		0.022
F	0.6		0.8	0.024		0.031
F1			0.9			0.035
G	2.41	2.54	2.67	0.095	0.100	0.105
G1	4.91	5.08	5.21	0.193	0.200	0.205
G2	7.49	7.62	7.8	0.295	0.300	0.307
H2			10.4			0.409
H3	10.05		10.4	0.396		0.409
L2	22.4		22.9	0.882		0.902
L3	25.4		26	1.000		1.024
L5	2.6		3	0.102		0.118
L6	15.1		15.8	0.594		0.622
L7	6		6.6	0.236		0.260
Dia.	3.65		3.85	0.144		0.152

